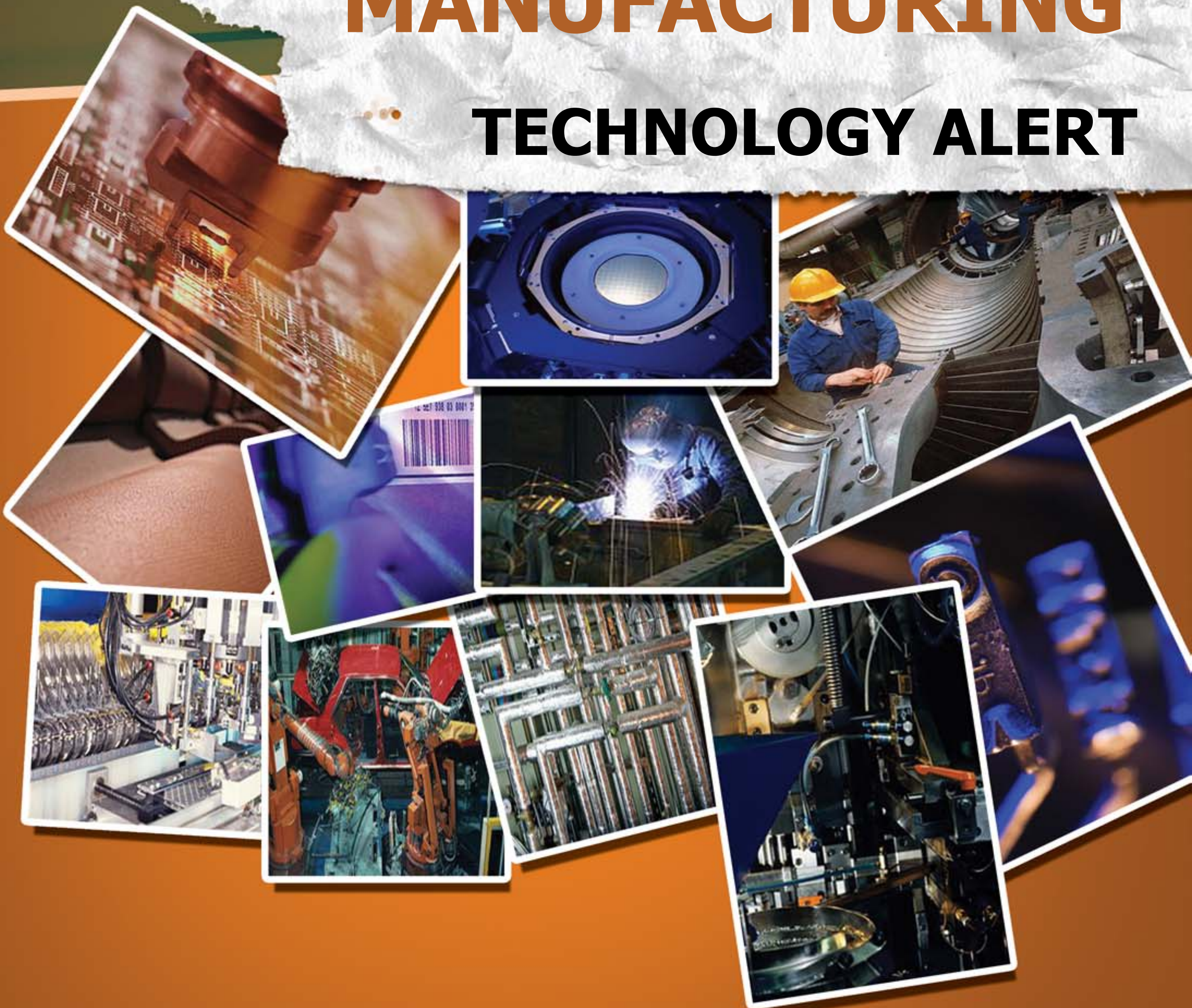
TECHNICAL INSIGHTS

ADVANCED MANUFACTURING

TECHNOLOGY ALERT



13th June 2014

1. MICRO MANUFACTURING PROCESS WITH HIGH SCALE PRECISION

Microscale fabrication can exhibit the advantages of traditional micromachining processes and newer methods, such as, LIGA--which is a combination of lithography, electroplating, and molding. Traditional micro manufacturing processes may have limitations for production of parts with finer features and better durability and tolerances. This has led to research initiatives that focus on the development of enhanced fabrication techniques for various products, including, semiconductors, and for machining parts, among others. Companies are focused on using microscale fabrication techniques for high-volume production processes that require precision manufacturing. This has gained even more importance as the precision manufacturing industry's need for scale reduction without sacrificing precision in a manufacturing process grows steadily.

In this regard, US-based Microfabrica Inc. has developed a proprietary process that is commercialized under the name, MICA FreeformTM. The developed process, like any three-dimensional (3D) printing technology and additive manufacturing process, can produce 3D objects from a digital model.

In the company's fabrication process, parts and devices are manufactured through forming and stacking thin metal layers. The manufacturing process begins with developing a 3D computer-aided design (CAD) model for the product, which is exported to an STL (stereolithography) file. The company uses a proprietary software program and divides the model into different two-dimensional (2D) cross sections. These cross sections form the basis for a set of photomasks, which are essentially quartz plates with submicrometer-resolution chrome patterns. These are used to define the areas on which the metal is electrodeposited, layer upon layer, until the original model is reproduced in solid form. The technology can be used to produce parts and devices that have thicknesses of less than 0.5 mm.

The use of the company's process allows for more design flexibility, and also eliminates the need for any further assembly. Also, the process can achieve the required high-volume production with extreme levels of precision. One of the advantages of the process is that the technology uses full dense metals to produce the required commercial solutions. From the time of its commercialization during 2009 to 2010, the company has been constantly innovating the process, and has fine-tuned it, so that it can be used for fabrication of finer features in end products, and can employ a wide variety of metals and alloys.

Apart from enabling the manufacture of multipart micro components, the process can also be used for manufacturing parts with internal channels and complex geometries that are difficult to produce using traditional techniques.

The company's fabrication process can be used across different industries, including aerospace, medical devices, semiconductors and automotive. It has potential application in industries where there is a need for miniaturization. Its adoption has been limited due to the widespread use of conventional manufacturing technologies. The company recently showcased its technology at the RAPID Conference and Exposition held at Detroit, MI on June 10 to June12, 2014.

Details: Eric Miller, CEO, Microfabrica Inc., 7911 Haskell Avenue, Van Nuys, CA 91406-1909. Phone: +1-888-964-2763. E-mail: emiller@microfabrica.com. URL: www.microfabrica.com.

2. INNOVATIVE PRODUCTION PROCESS FOR REDUCING CHANGE OVER TIME

A significant amount of research has been carried out to enable the manufacturing of a small series of individualized products that could be manufactured rapidly and more efficiently by means of intelligent machines that are capable of communicating with each other.

Researchers from Karlsruhe Institute of Technology (KIT) in Germany have been working on developing a process called plug and produce for significantly reducing the changeover times in the production process. This research has been carried out from the grant obtained from SkillPro an EU-funded research project for developing novel manufacturing techniques and solutions. During manufacturing of any product or component in any industry, there is a need for modifying the production tools required for the production of a new product. This changeover time poses a major drawback while mass manufacturing of products as it takes a longer time for preparing the machines than that of the actual manufacturing process. In order to overcome the above-mentioned drawback, the researchers have equipped machines with additional features that have enabled reducing the changeover time, thereby increasing the efficiency. This process includes having the machines equipped with camera sensors that allow them to recognize any workpiece during the manufacturing of new products. By examining the shape and position of the workpiece, the machines would be able to decide on the way that the gripper or suction caps can be applied on the workpiece. Based on the final product to be manufactured, the machines--equipped with gripping, welding or bonding functions--would be able to determine the next task or step that is required in the production. The machines then communicate with the neighboring machines and decide on whether there is a mobile robot to transport the product from one workstation to another or to any other place in the factory. According to the researchers, the plug and produce process allows the machines to autonomously adjust themselves according to the product that is to be manufactured, which is seen as a key advantage of this novel process. Before the production process is initiated, a set of algorithms calculate the assembly line for the end product to be manufactured efficiently. The sequence of the production activities that are simulated in the planning stage and the real-time production activities are displayed on a screen for the user. This process can be integrated to the existing set of machines, thereby improving their technical capabilities. The researchers believe that this novel production process would be of significant value in the factories of the future.

Some of the advantages of the plug and produce process is that it significantly reduces the changeover time required in the manufacturing of new products, and increases the overall efficiency of the production. This process has a significantly high value in developing the factories of the future.

Details: Monika Landgraf, Chief Press Officer, Head of Press Office, Karlsruhe Institute of Technology, Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen, Germany. Phone: +49-721-608-47414. E-mail: monika.landgraf@kit.edu. URL: www.kit.edu.

3. APPROACH TO MAKE INDUSTRIAL ROBOTS MORE ENERGY EFFICIENT

The automotive industry has been one of the sectors in which the adoption of robots has been significant. Companies and research institutes are focusing on reducing the amount of energy consumed in the operation of robots.

Siemens (Germany) has analyzed the key factor for high power consumption in robots and has developed a solution that is expected to significantly reduce the amount of power consumed. For this research, Siemens collaborated with Volkswagen and Fraunhofer Gesellschaft, Germany, as part of the Green Carbody Technologies (InnoCaT) innovation alliance. Through this research, Siemens aims to further reduce the power consumption of robots employed in manufacturing processes in the automotive industry. One of the key factors that have been identified for increased power consumption is the movement patterns of the robots. By studying the motion sequences of the manufacturing robots, the above-mentioned issue could be resolved. The partners of this research had developed a simulation model for calculating the best trajectories for the robots from the energy efficiency standpoint. From the various tests that were carried out, it was found that this novel approach developed by Siemens could reduce the energy consumption by almost half. There is also a need for developing software programs that could be used for re-programming the existing robots to operate in a more efficient way without making more changes in the production process. In the automotive industry, especially in the body shell production unit, a large number of robots are being employed and it has been found that these robots consume more than half of the total energy consumption. One of the key approaches for resolving the above-mentioned challenge is by making changes to the control systems. The researchers had analyzed the energy consumption of the robots during various work steps in their laboratory tests. Through these tests they were able to analyze the extent to which the directional changes influence the power consumption, and thereby determine the parameters that result in the optimum patterns of movement for reducing energy consumption. Based on the results, changes were made to the simulation, which resulted in significant reduction of power consumption. In addition to the reduction in power, it was found that stress on the mechanical parts of the robots was also significantly reduced. Siemens is currently working on integrating the new algorithm that was developed in this research into its industrial robots.

Some of the advantages of this research are that it increased the efficiency of the robots in terms of reduced power consumption, and also increased the durability and life cycle of the robots by reducing the stress on the mechanical parts of the robots. Due to the increase in adoption of robots in various industries, this research has potential to aid a large number of industrial sectors.

Details: Günter Gaugler, PR contact, Siemens, Wittelsbacherplatz 2, 80333 Munich, Germany. Phone: +49-89-636-34782. E-mail: guenter.gaugler@siemens.com. URL: www.siemens.com.

4. PATENT ANALYSIS OF REACTION INJECTION MOLDING

Reaction injection molding is a variation of injection molding and has been popular in manufacturing industries. In this type of molding, the commonly used materials are thermosetting polymers, which require long curing time and the curing has to be carried out inside the mold itself. This type of molding process is usually employed by the automobile manufacturers for producing parts, such as, bumpers, air spoilers, and fenders. The other materials used in this type of molding are polyurethane, polyesters, and polyphenol. This method is preferred by industries because of its ability to produce lightweight parts with high strength and flexibility.

The reaction injection molding process employs a dry tank that stores the reinforced components. These components are slowly mixed with impellers to prevent the settling of fibers. Some of the dry tanks may be employed with a heating jacket for controlling the temperature and pressure of the components. The materials from the dry tanks are then moved into the metering cylinder with the help of feeder pumps. Once the metering cylinders are filled, the material is then pushed in the forward direction toward the mix head by using hydraulic plunger at a fixed pressure . During this initial travel of the hydraulic plunger, the passage from the valve to the mixing chamber is closed, thereby recirculating the components through the return lines back into the tank. The mix chamber is a small cylinder into which the components are made to enter from the opposite sides of the chamber. These mix heads are developed in such a way that turbulence is created in order to mix the components together. This turbulence is created at a very high pressure, which is usually between 1500 psi to 3000 psi. Once the required amounts of components are mixed together, the valve is closed again and the components are made to flow back into the dry tank. The molds are usually filled with 90% of the components and the rest is filled by the expansion of the material inside the mold. The reaction and binding time for the components is usually somewhere between 2 seconds to 10 seconds from the start of injection. The mold is kept closed for a specific amount of time based on the part being manufactured and then it is removed. Most of the resin components manufactured through this molding process is post-cured using an oven.

The recent patent filings, as exhibited, indicate that companies and universities are carrying out research to improve the reaction injection molding process for materials such as polyureas or polyurea-urethanes.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Precision polyurethane manufacture	July 30, 2013/EP 1935622 A1	Ranier Limited	Geoffrey Thomas Andrews, Anthony Francis Johnson	The present invention relates to a process for making a polyurethane, comprising reacting a multifunctional isocyanate, a polyol and, optionally, a chain extender, wherein at least two reagents selected from the isocyanate, the polyol, the chain extender, any mixture thereof and any pre-polymer formed therefrom, are intensively mixed prior to forming a polyurethane having a predetermined stoichiometry and thermal history.
Formulations for reaction injection molding and for spray systems	January 09, 2008/WO 2008086437 A1	Albermale Corporation	William R. Brown, John Y. Lee, Paul L. Wiggins	This invention provides articles made by reaction injection molding and spray coatings, and processes for forming such articles and coatings. The coatings and articles are polyureas or polyurea-urethanes. The ingredients used to form the coatings and articles comprise at least (A) an aromatic polyisocyanate and (B) a mixture formed from components comprised of (i) at least one polyol and/or at least one polyetheramine, (ii) an aromatic primary diamine, and (iii) an aliphatic secondary diamine which has about twelve to about forty carbon atoms and in which the having amino hydrocarbyl groups are secondary or tertiary hydrocarbyl groups.
Formulations for reaction injection molding and for spray systems	January 09, 2008/EP 2102265 A1	Albermale Corporation	William R. Brown, John Y. Lee, Paul L. Wiggins	This invention provides articles made by reaction injection molding and spray coatings, and processes for forming such articles and coatings. The coatings and articles are polyureas or polyurea-urethanes. The ingredients used to form the coatings and articles comprise at least (A) an aromatic polyisocyanate and (B) a mixture formed from components comprised of (i) at least one polyol and/or at least one polyetheramine, (ii) an aromatic primary diamine, and (iii) an aliphatic secondary diamine which has about twelve to about forty carbon atoms and in which the having amino hydrocarbyl groups are secondary or tertiary hydrocarbyl groups.
Mixing head for a reaction injection molding machine	March 09, 2006/US 20060050607 A1	Krauss-Maffei Kunststofftechnik Gmbh	Robert Brunner, Stefan Ehrlicher	A mixing head for a reaction injection molding machine includes a body including a mixing chamber formed with an injection bore. In addition to a charging assembly for introducing at least two reactive components into the mixing chamber, there is provided a feed assembly having at least two feeds for supply of different additional components to the mixing chamber. A moveable adapter selectively and detachably couples the feeds of the feed assembly to the injection bore for selective introduction of the additional components. The adapter is constructed for rotation in relation to the mixing chamber so that an exit port of each feed is connectable with the injection bore through rotation of the adapter.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Processes for production of plastic lenses, gasket for molding plastic lenses, molds for molding plastic lenses, injection jig for the raw material fluid of plastic lenses, holding fixture for the molds for plastic lenses, and production unit for plastic lenses EP 1759824 A1	June 08, 2005/EP 1759824 A1	Hoya Corporation	Akira Hamanaka, Hideki Kobayashi, Yasuhisa Okamoto, Yukiaki Sunagawa, Nobuhiko Takeda	A method of manufacturing a plastic lens by mixing plural polymerizable components, and immediately after mixing, casting a mixture into a casting mold and conducting polymerization to obtain a molded article. A method of manufacturing a plastic lens by casting a plastic lens starting material liquid flowing out of a casting jig opening into a casting mold and curing the above starting material liquid to form a molded article. A gasket for molding plastic lens comprised of a cylindrical member comprising openings for fitting by insertion two molds. A casting mold for molding plastic lens, wherein the above molds are detachably held in the above openings of the above gasket so that molding surfaces of the two molds are positioned opposite at a prescribed interval to form a cavity corresponding to a lens shape within the above cylindrical member. A casting jig for plastic lens starting material liquid equipped with a nozzle for casting a plastic lens starting material liquid into the casting mold. A method of manufacturing a plastic lens comprising casting of a plastic lens starting material liquid into a casting mold held by a holding member and curing the above starting material liquid to form a molded article. A holding member for plastic lens casting mold for holding a casting mold for molding a plastic lens.
Mixing head for a reaction injection molding machine	September 26, 2005/US 20060050607 A1	Krauss-Maffei Kunststofftechnik Gmbh	Robert Brunner, Stefan Ehrlicher	A mixing head for a reaction injection molding machine includes a body including a mixing chamber formed with an injection bore. In addition to a charging assembly for introducing at least two reactive components into the mixing chamber, there is provided a feed assembly having at least two feeds for supply of different additional components to the mixing chamber. A moveable adapter selectively and detachably couples the feeds of the feed assembly to the injection bore for selective introduction of the additional components. The adapter is constructed for rotation in relation to the mixing chamber so that an exit port of each feed is connectable with the injection bore through rotation of the adapter.
Garage door cladding system and method	August 17, 2004/WO 2005019582 A2	Warner Industries, Llc, William Kent Warner Iii	William Kent Warner Iii	A door cladding system (22) has a number of composite panels (26) with a wood grain surface. An attachment system (36) holds the composite panels (26) onto a front surface of a door (14).

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
High performance reaction injection molding (RIM) poly(urethane)urea elastomers and a process for their production	May 26, 2003/EP1369444 A1	Bayer Corporation	Michael F. Hurley, Bruce H. Potts, William E. Slack, David D. Steppan, Michael S. Super	This invention relates to high performance RIM (reaction injection molded) poly(urethane)urea elastomers, and to a process for their production. These elastomers comprise the reaction product of an allophanate-modified diphenylmethane diisocyanate prepolymer having an NCO group content of about 5 to about 30%, with an isocyanate-reactive component comprising a high molecular weight amine-terminated polyether polyol, an aromatic diamine chain extender, and, optionally, a chain extender or crosslinker selected from the group consisting of aliphatic amine terminated polyether polyols and aliphatic hydroxyl terminated polyether polyols, optionally, in the presence of an internal mold release agent, a surfactant and a filler.
Reaction injection molding process	February 15, 2001/EP1257408 B1	Dow Global Technologies, Inc.	John W. Mclaren	The invention comprises a mold useful for the preparation of a polyurethane based article comprising a metal coated on the surfaces to come in contact with the polyurethane materials wherein the coating is a continuous matrix of cobalt or nickel having dispersed in such discontinuous matrix a fluorinated polyolefin polymer. In another aspect the invention is a process for injection molding a part from polyurethane materials which process comprises injecting polyurethane based materials into a mold as described above, exposing the injected materials to conditions such that a solidified article is formed and removing the formed article from the mold. In another aspect the invention is an article comprising polyurethane material prepared by injection molding which contains about 0.5 percent by weight or less of an internal mold release and which can be coated in an industrial coating process without the need for a sealer coated on the article.
Mold for reaction injection molding and reaction injection molding process	February 15 ,2001/WO 2001060591 A1	The Dow Chemical Company	John W. Mclaren	The invention comprises a mold useful for the preparation of a polyurethane based article comprising a metal coated on the surfaces to come in contact with the polyurethane materials wherein the coating is a continuous matrix of cobalt or nickel having dispersed in such discontinuous matrix a fluorinated polyolefin polymer. In another aspect the invention is a process for injection molding a part from polyurethane materials which process comprises injecting polyurethane based materials into a mold as described above, exposing the injected materials to conditions such that a solidified article is formed and removing the formed article from the mold. In another aspect the invention is an article comprising polyurethane material prepared by injection molding which contains about 0.5 percent by weight or less of an internal mold release and which can be coated in an industrial coating process without the need for a sealer coated on the article.

Exhibit 1 depicts patents related to reaction injection molding.

Picture Credit: Frost & Sullivan

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